

# BACK RIVER OUTFALL INTERCEPTOR REHAB

Open Discussion  
With

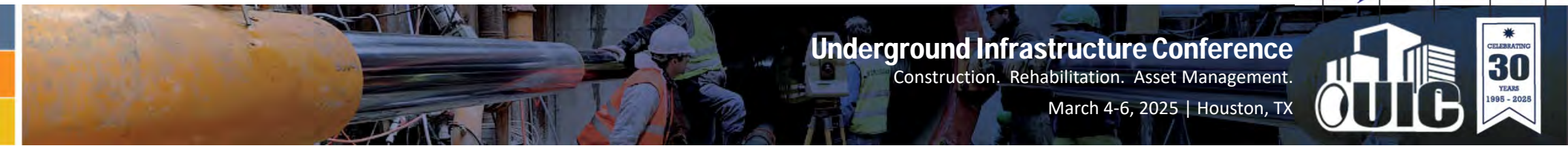
Steven Walsh  
Project Manager  
Ulliman Schutte



Linda Cassel  
Project Manager  
Boyer, Inc.



Bill Grubbs  
Design Engineer  
Boyer, Inc.



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# HISTORY & BACKGROUND

- BACK RIVER OUTFALL INTERCEPTOR (BROI)
- 11' X 12' ARCHED SANITARY SEWER
- 8201 EASTERN AVE, BALTIMORE, MD
- BUILT IN LATE 1907 /1908
- SERVICES 74% OF BALTIMORE SERVICE AREA , ADF 180 MGD



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# HISTORY & BACKGROUND

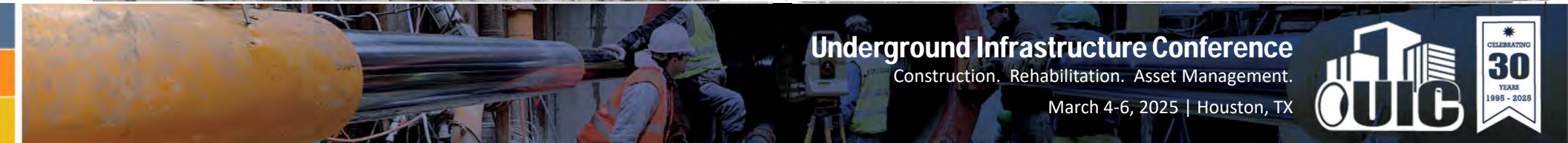


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# HISTORY & BACKGROUND



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# PROJECT BACKGROUND

## Project team

Owner: City of Baltimore

GC: Ulliman Schutte Construction

EOR: KCI Technologies, Inc.

Lining Subcontractor: Boyer, Inc.



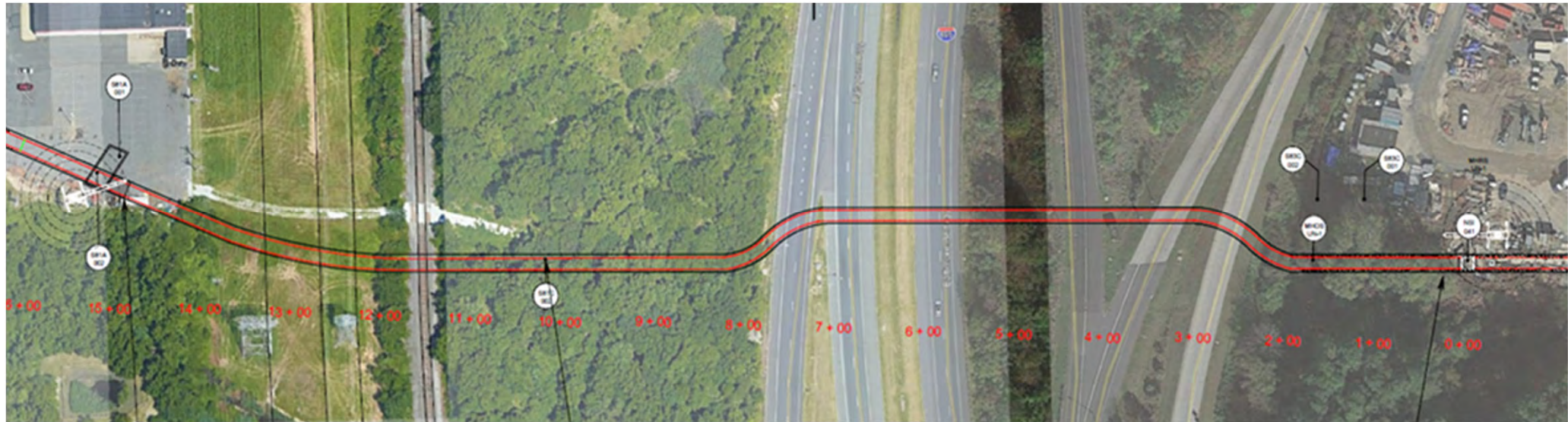
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# LIMITS OF WORK

A photograph of construction workers in a tunnel. They are wearing hard hats and safety vests. One worker is operating a surveying instrument on a tripod. The tunnel walls are dark and reflective.

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CELEBRATING  
**30**  
YEARS  
1995 - 2025



# ANTICIPATED CHALLENGES

## **Diversion of flow**

- Divert approx. 137 MGD from BROI to parallel 120" relief sewer
- Two 30" vent Chambers Diverted to relief sewer

## **Railroad coordination**

- Cross RR tracks
- Confirm rehab design under E80 load

## **Curves in BROI**

- Bracing system



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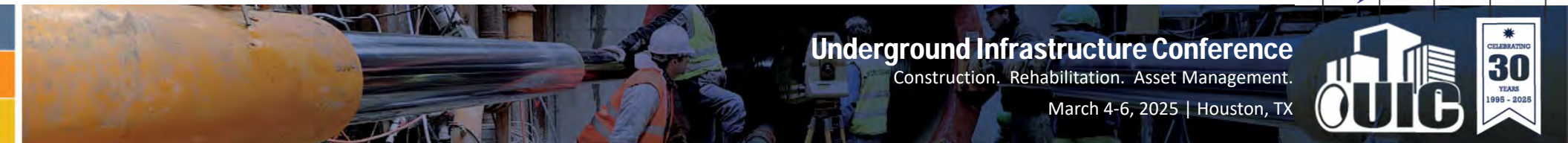
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# DIVERSION OF FLOW

## Diversion Chamber

- Located in isolated parking lot
- Relocate Buried Power Transmission lines
- USC begins construction of 49' x 30' diversion structure



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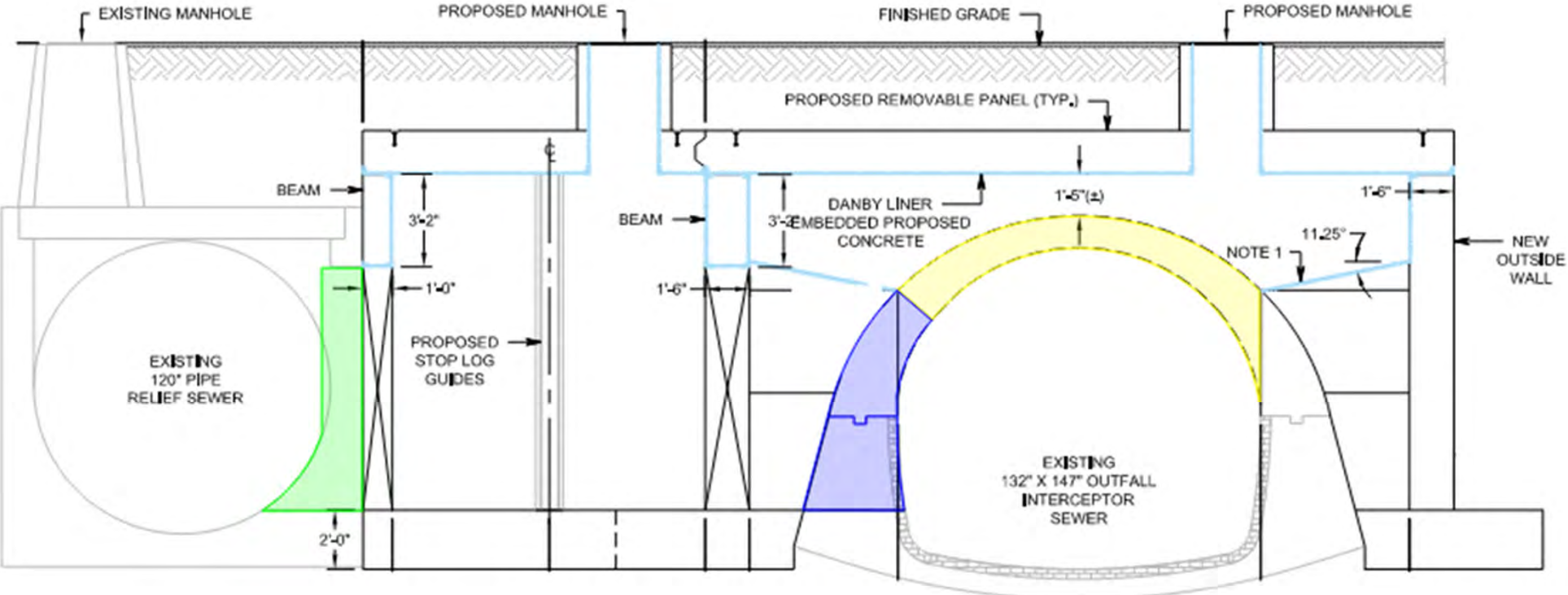
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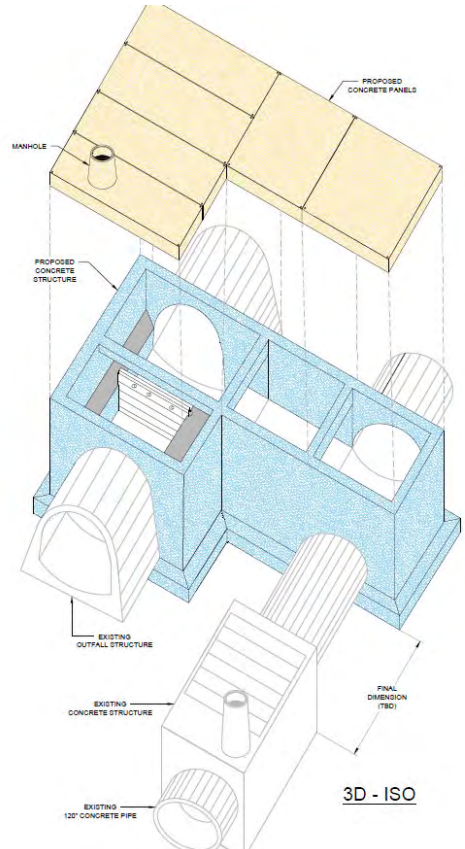
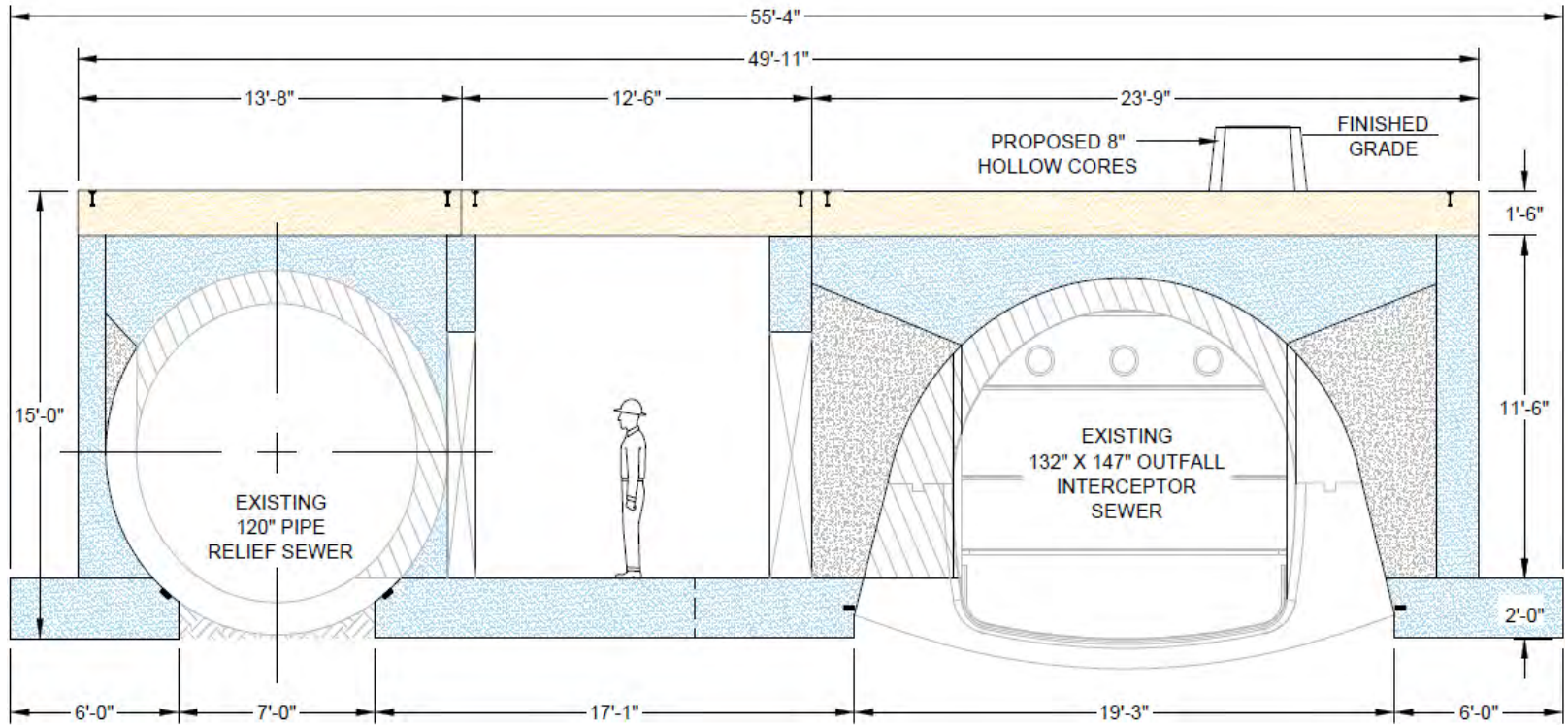
# DIVERSION OF FLOW



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# DIVERSION OF FLOW



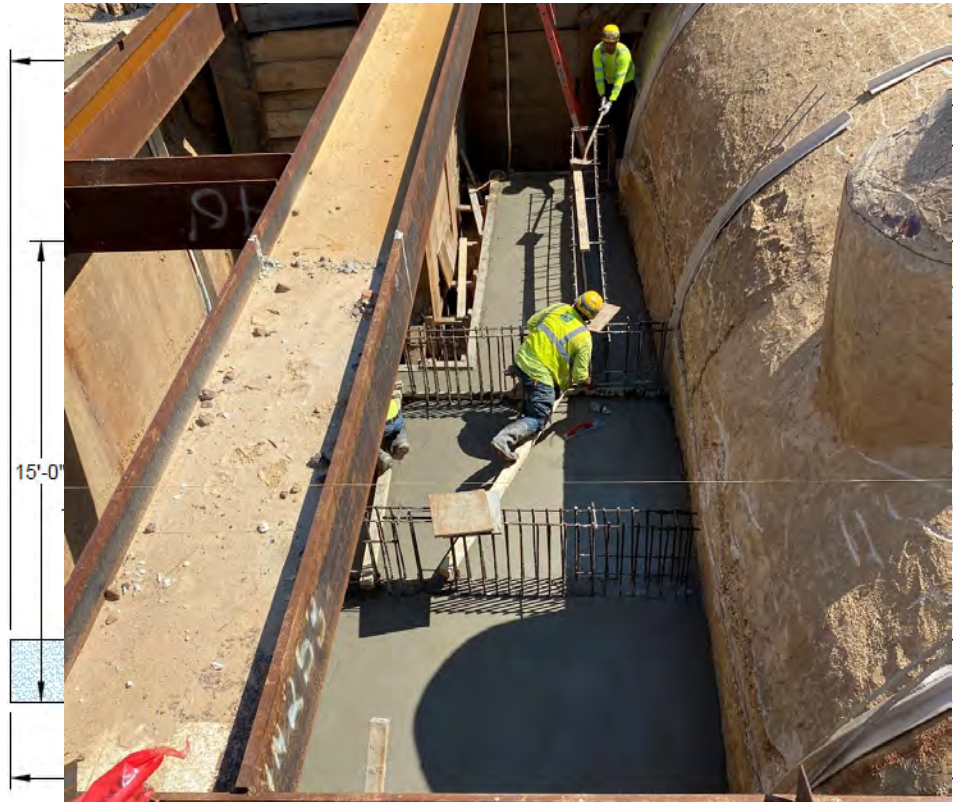
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**OUIC**

CELEBRATING 30 YEARS 1995 - 2025



# DIVERSION OF FLOW





# DIVERSION OF FLOW



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# DIVERSION OF FLOW



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# TWIN VENT CHAMBERS W/ FORCE MAINS

## Extended & diverted to relief sewer

- Easterly (EVC) & Westerly (WVC) vent chambers were vertically extended
- 24" & 30" force mains diverted to relief sewer
- USC begins construction and installs diversion



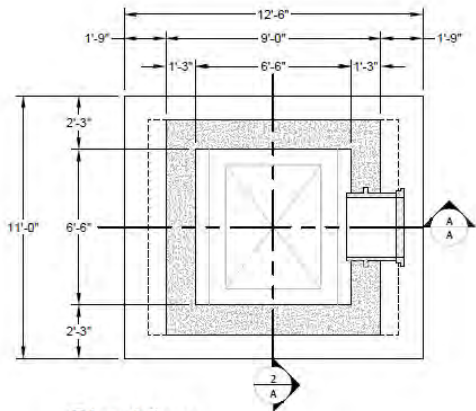
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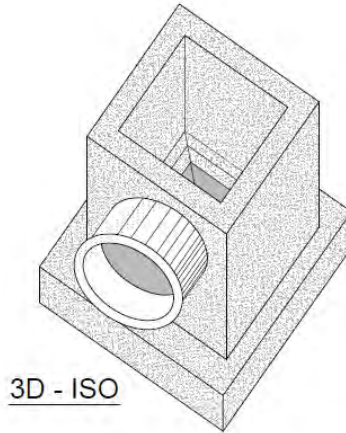
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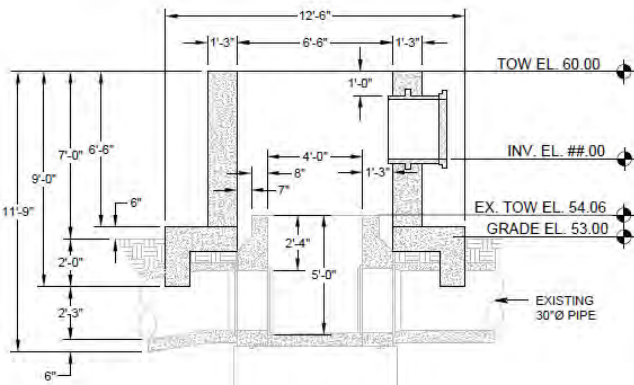




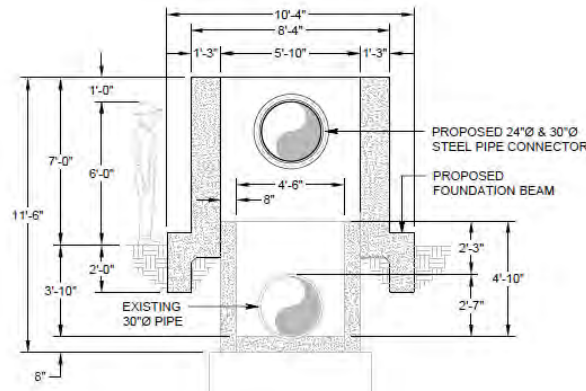
**Plan View**  
SCALE:  $\frac{3}{16}'' = 1'-0''$



**3D - ISO**



**Section 1**  
SCALE:  $\frac{3}{16}'' = 1'-0''$



**Section 2**  
SCALE:  $\frac{3}{16}'' = 1'-0''$



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# CONFINED SPACE / ACCESS

## Confined Space Plan

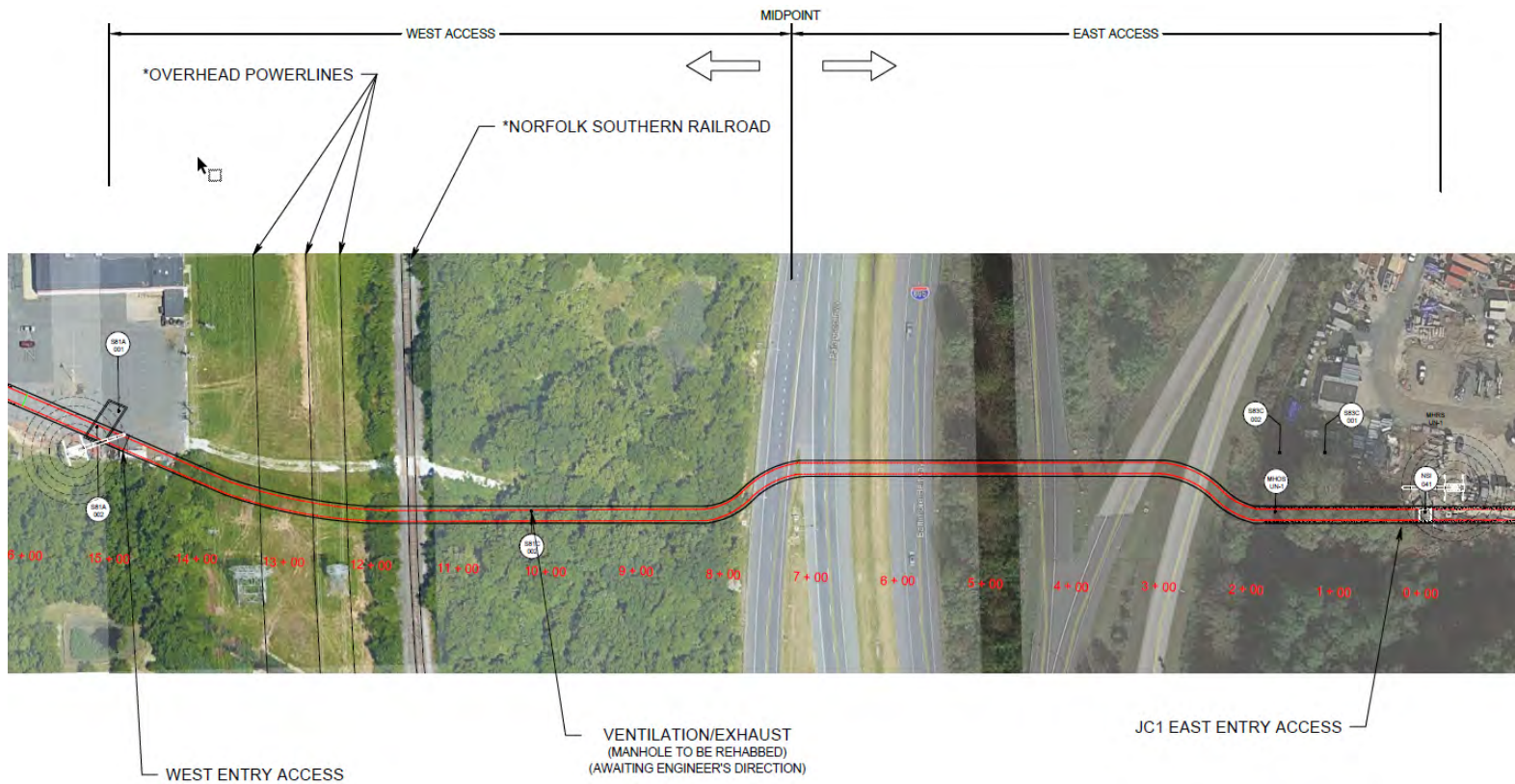
- Access
- Ventilation



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# CONFINED SPACE / ACCESS Cont'd



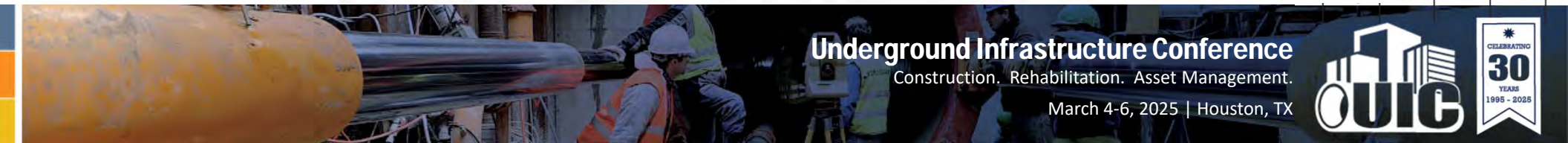
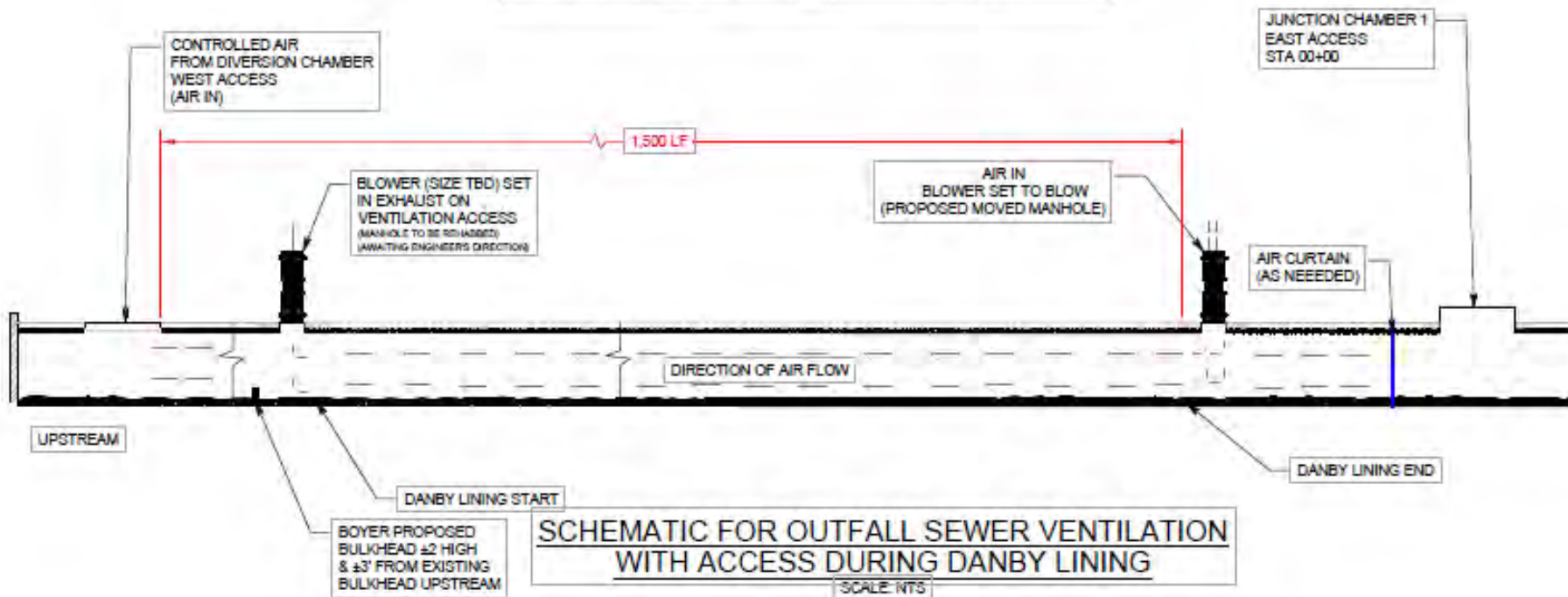
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# CONFINED SPACE / ACCESS Cont'd

1,500 LF	
CONDUIT CROSS SECTIONAL AREA	132 SQUARE FEET
VOLUME OF AIR TO BE CHANGED	196,000 CUBIC FEET
REQ'D VOLUME OF AIR PER INDIVIDUAL	200 CFM



# CONFINED SPACE / ACCESS Cont'd



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# CONFINED SPACE / ACCESS Cont'd





# CONFINED SPACE / ACCESS Cont'd



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# CONFINED SPACE / ACCESS Cont'd



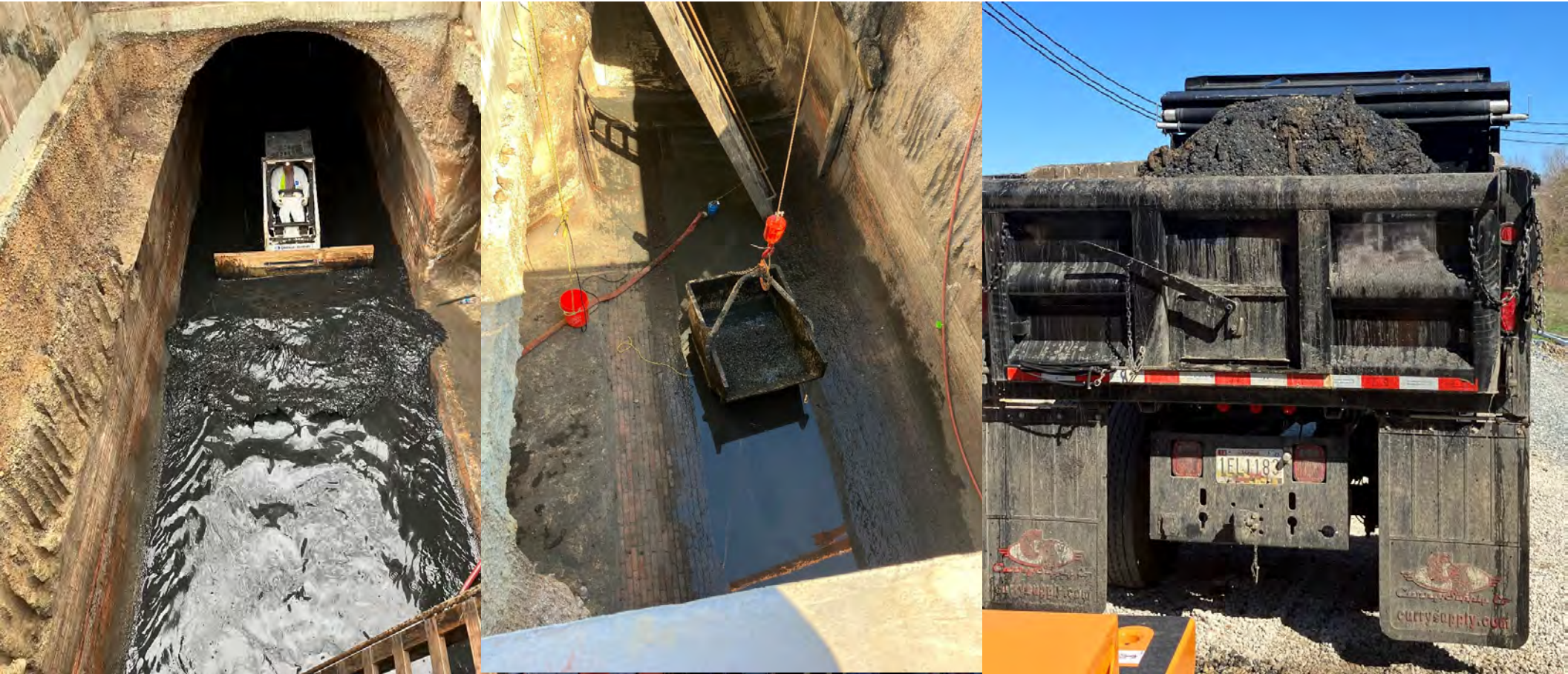
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# CLEANING

- BULK DEBRIS REMOVAL





# CLEANING Cont'd

- HYDRO-BLASTING

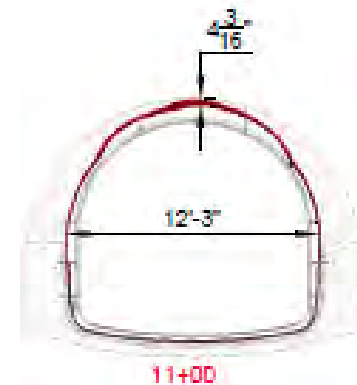
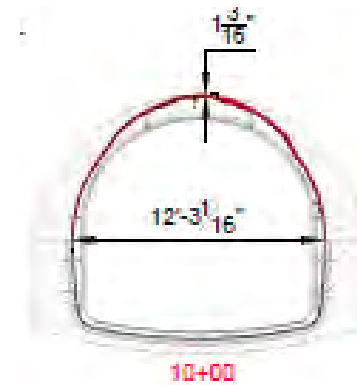




# INVESTIGATION

Severe Deterioration and H<sub>2</sub>S damage

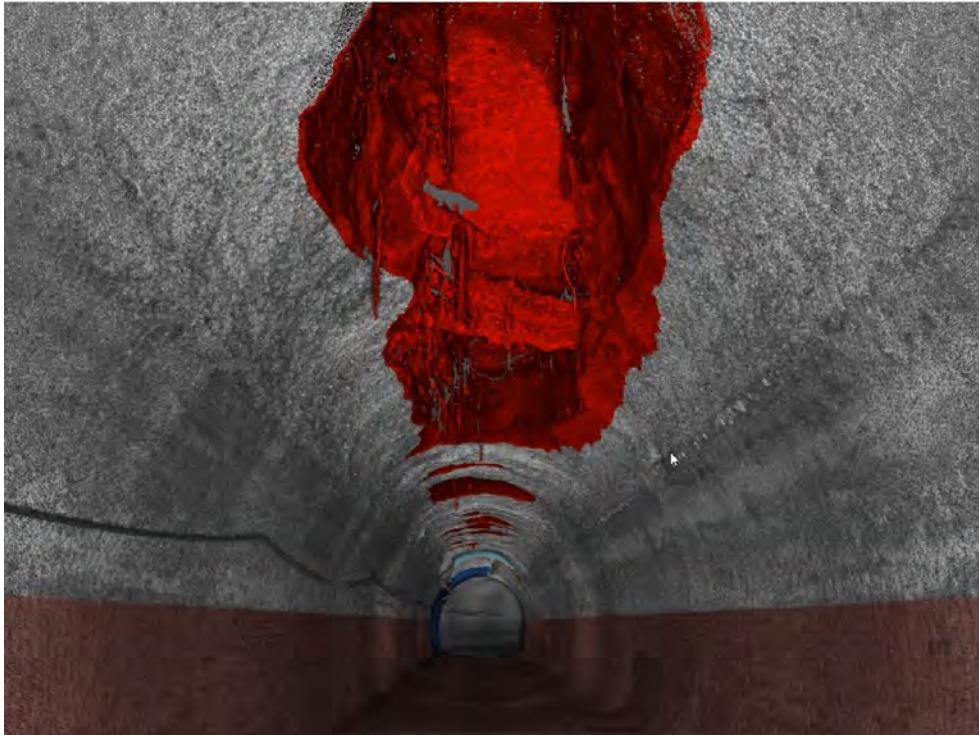
- CCTV INSPECTION
- LiDAR 3D SCAN
- CONDITION ASSESSMENT & FINITE ELEMENT ANALYSIS



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# INVESTIGATION



City of Baltimore, Department of Public Works - East River, SC, 1226  
Slideshow - April 20, 2023 - Photo 4

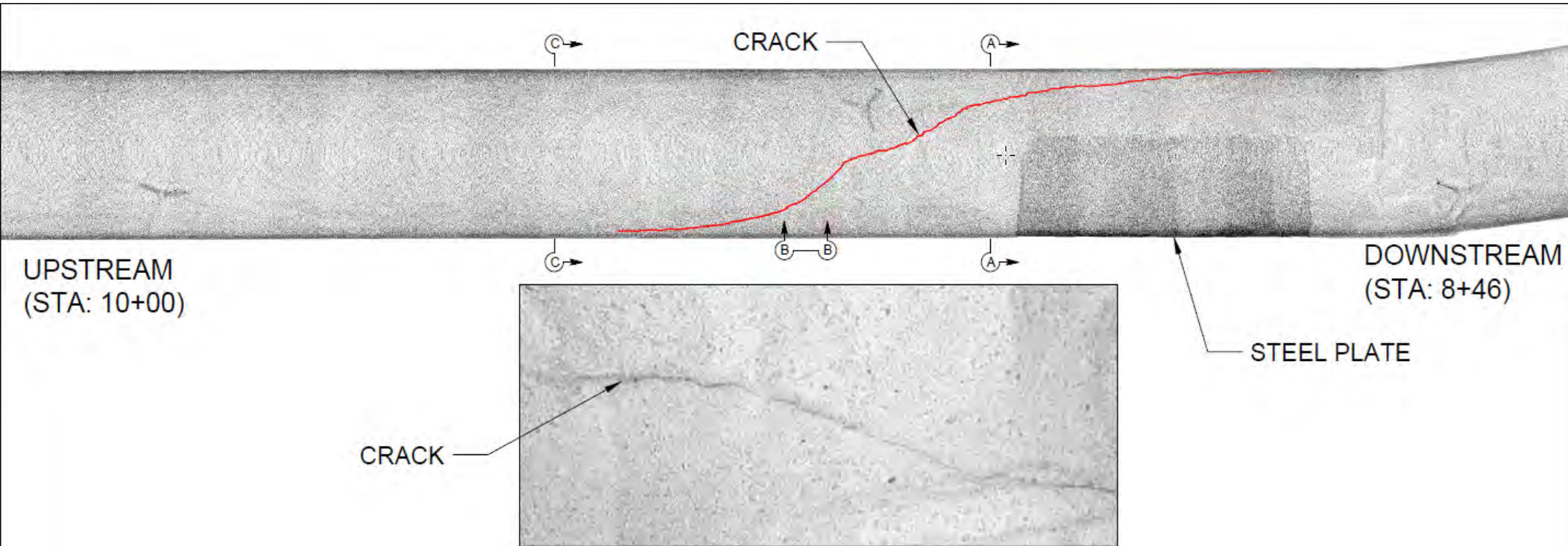


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# INVESTIGATION



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# INVESTIGATION



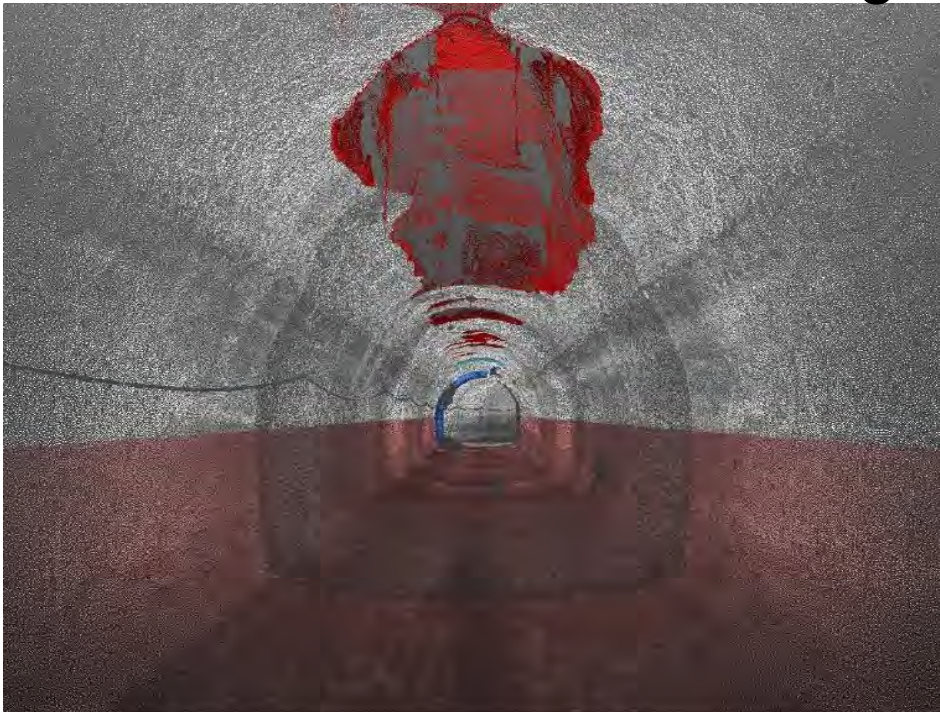
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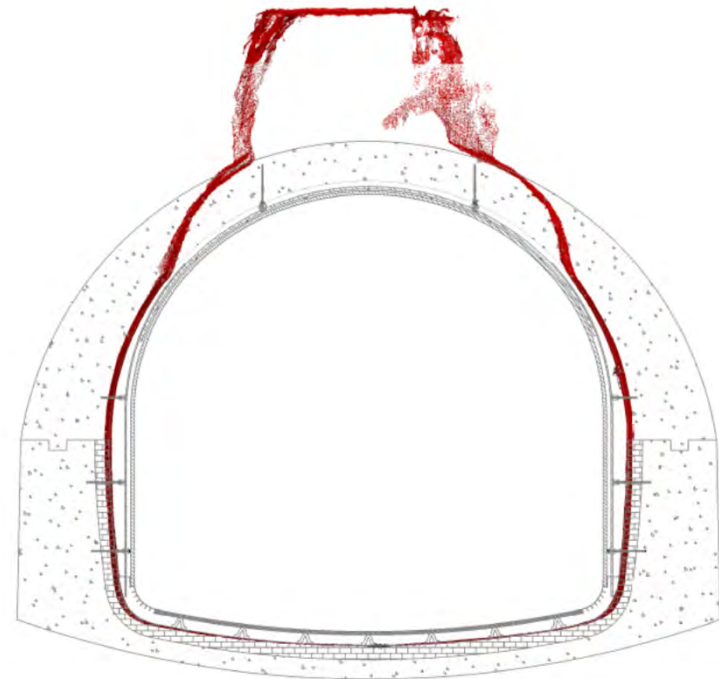


# INVESTIGATION

## Laser-to-Digital Cross-Section



=




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# INVESTIGATION Cont'd

A background image showing construction workers in safety gear working on a large pipe or tunnel. The scene is dimly lit, with workers in orange safety vests and hard hats.

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# INVESTIGATION Cont'd

Background image of construction workers in a tunnel.

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# INVESTIGATION Cont'd



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# INVESTIGATION Cont'd



x: 01/4" y: 214'-73/8" z: 2'-03/4"

Distance 3D View

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# INVESTIGATION Cont'd




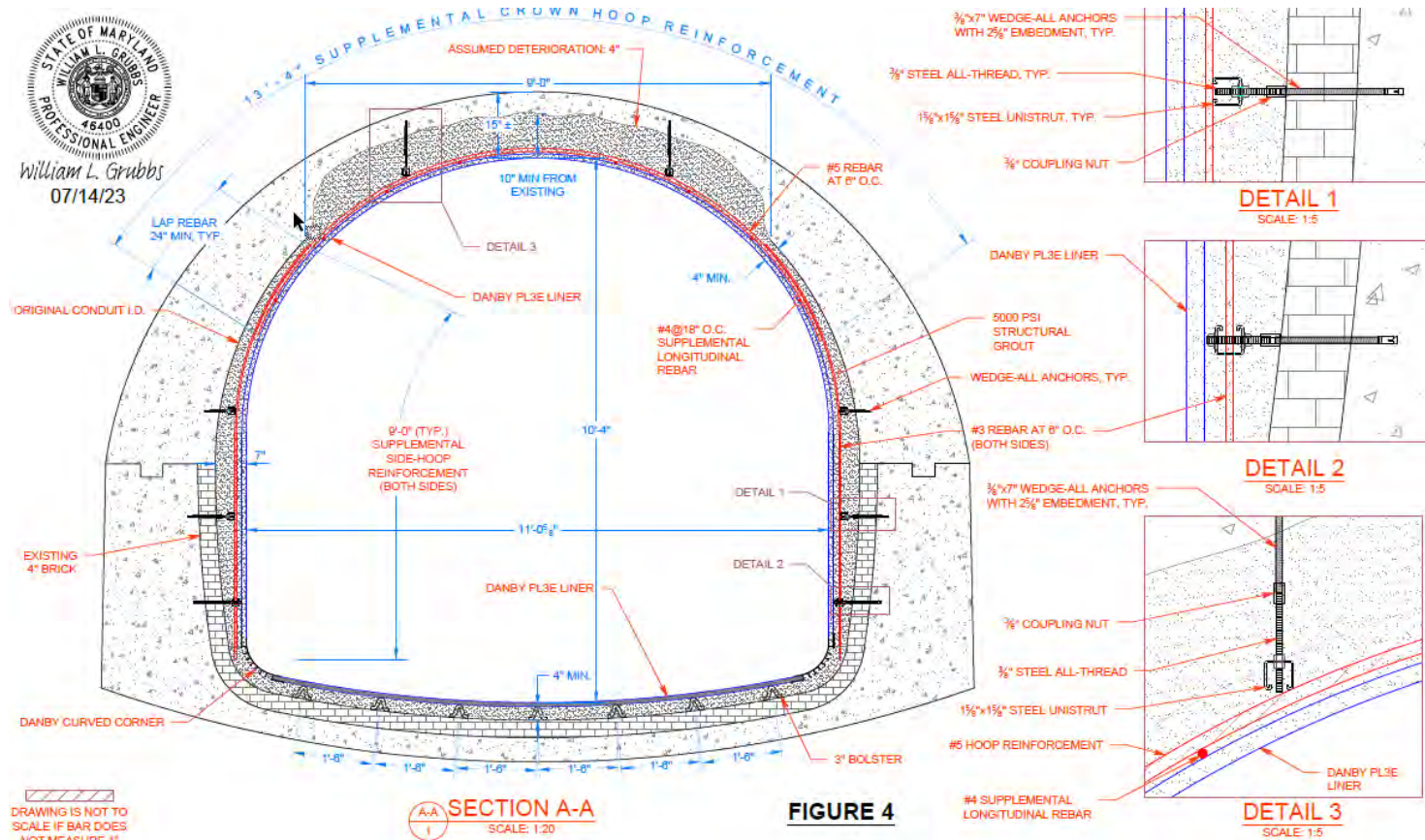
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# DESIGN

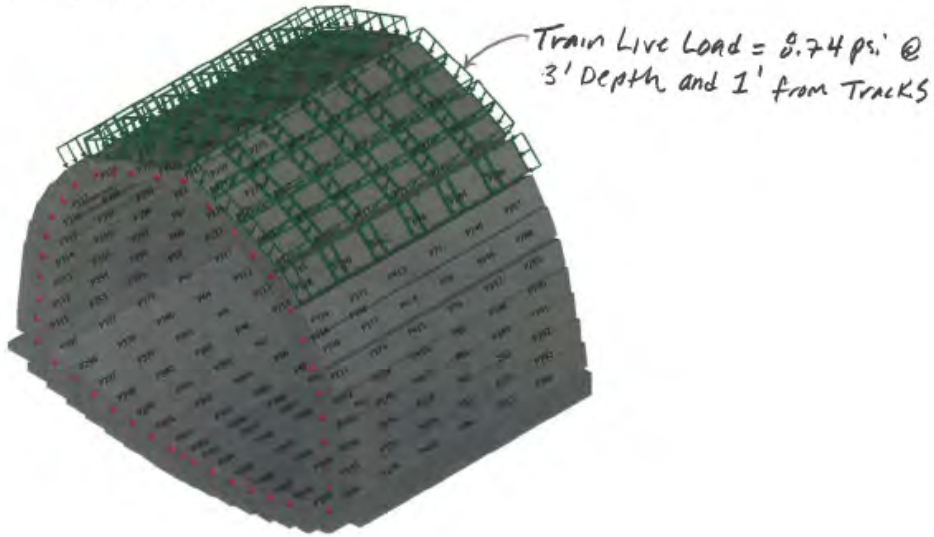
  
 William L. Grubbs  
 07/14/23



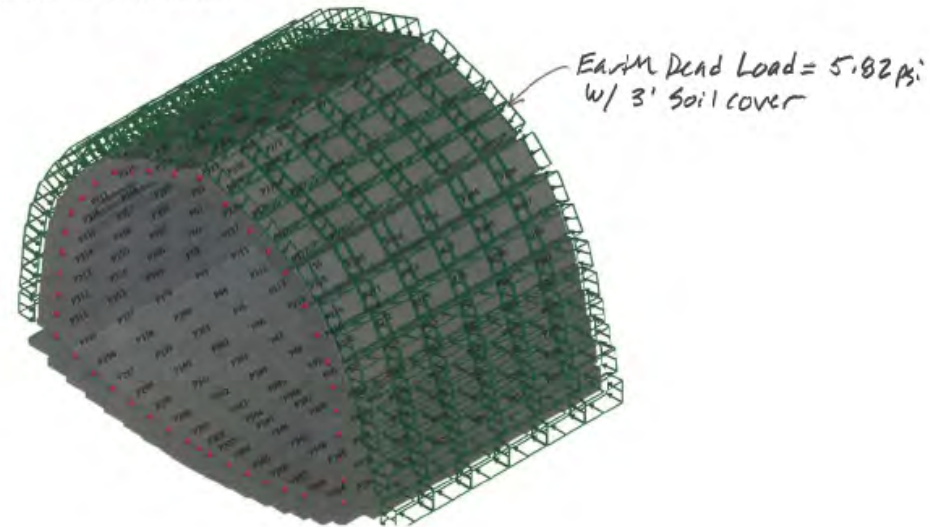
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# DESIGN

+ Full WW Live Load\_WITH SOIL LOADING.vap



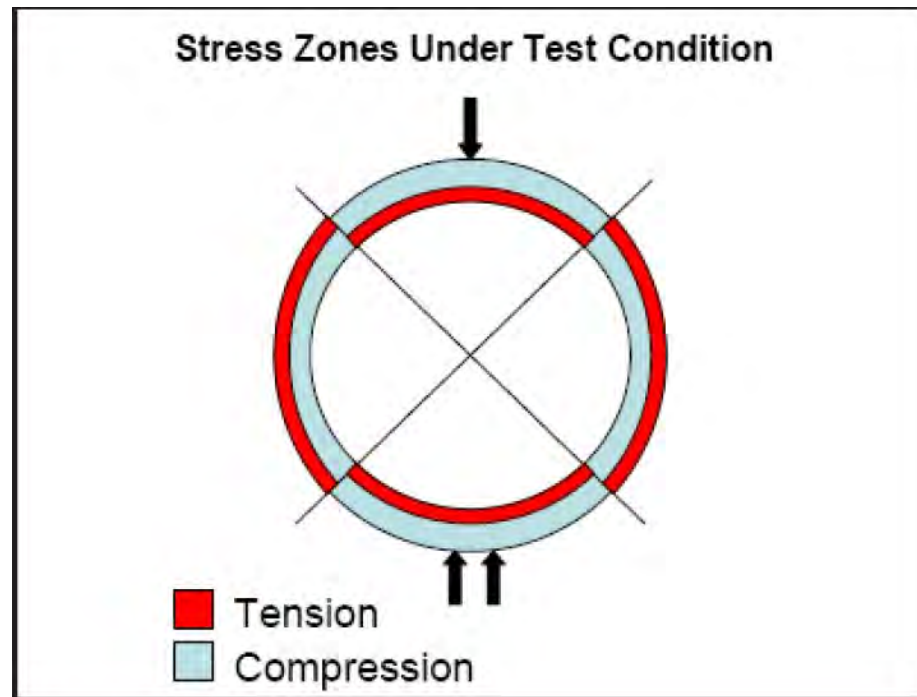
Dead Load + Full WW Live Load\_WITH SOIL LOADING.vap





# DESIGN Cont'd

## Concentrated Tensile & Compression Stresses



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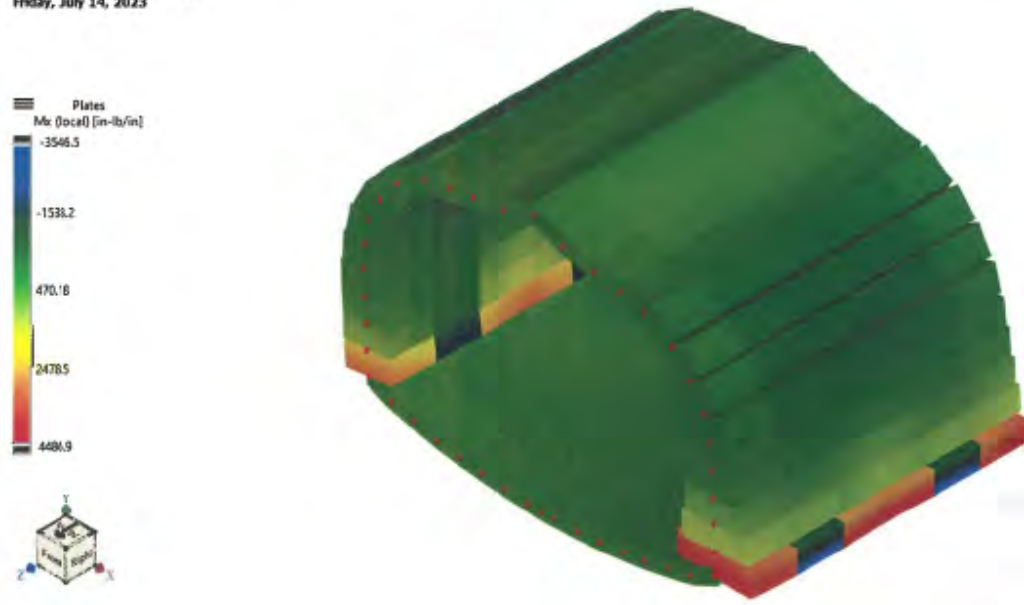
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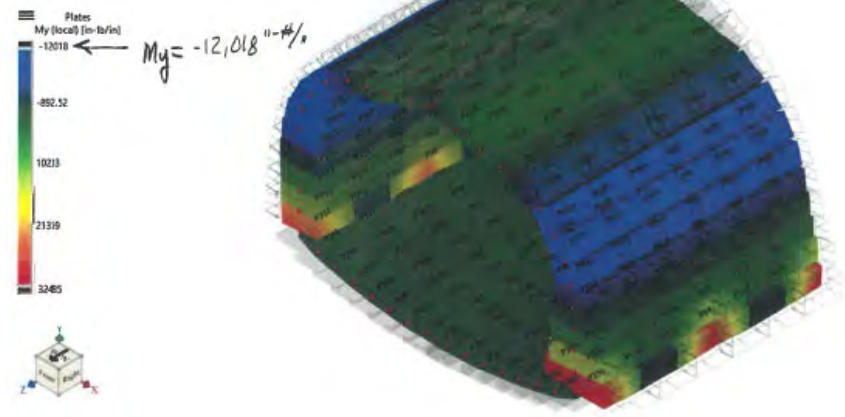


# DESIGN

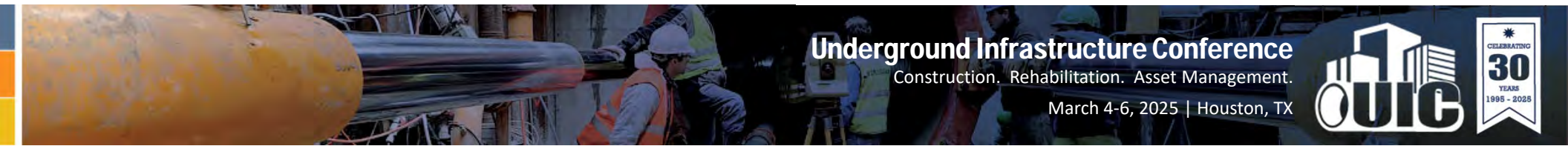
Baltimore FEA\_07\_06\_23\_Grit Dead Load + Full WW Live Load\_WITH SOIL LOADING.vap  
Result Case: Railroad Live Load  
IES VisualAnalysis 21.00.0003  
Friday, July 14, 2023



Baltimore FEA\_07\_06\_23\_Grit Dead Load + Full WW Live Load\_WITH SOIL LOADING.vap  
Result Case: 1.2 Earth Load + 1.4 WW Load + 1.6 RR Load  
IES VisualAnalysis 21.00.0003  
Tuesday, July 11, 2023



FEA

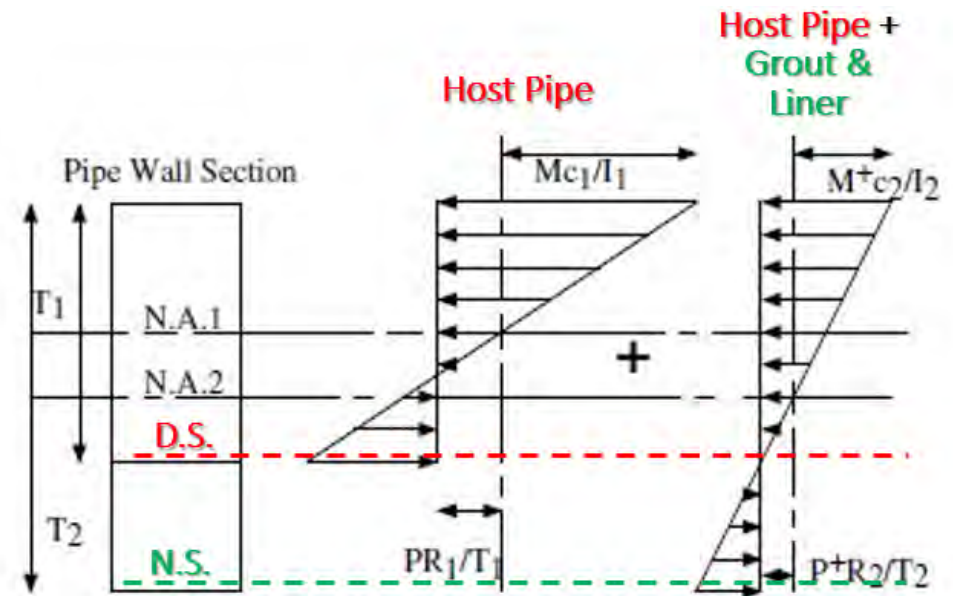




# DESIGN Cont'd

## Danby Design Objective

1. Determine magnitude of induced moment ( $M+$  or  $M-$ ) due to loading
2. Determine the “current state of stress”
3. Determine “critical value” of tension stress and where located (crown or S.L.)
4. Compare “critical value” stress to modulus of rupture concrete and H.S. grout
5. Design wall thickness to achieve required safety factor



DS = Deteriorated Surface  
NS = New Surface

# REHABILITATION



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# REHABILITATION Cont'd



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# REHABILITATION Cont'd

- Grouting

- 5000 PSI STRUCTURAL GROUT
- INSTALLED IN 12" LIFTS
- MADE ON SITE
- 14-20 SECONDS FLOW CONE

**DANBY GROUT MIX DESIGN FOR 1000 LBS OF CEMENTITIOUS MATERIAL**

MATERIAL	SPECIFIC GRAVITY	DENSITY (LBS/CF)	WEIGHT (LBS)	GAL	VOLUME CF	W/C RATIO	
TYPE I/II PORTLAND CEMENT	3.125	195	600		3.1	<b>0.33</b>	
CLASS "F" FLY ASH	2.5	156	400		2.6		
WATER	1	62.4	333.6	40	5.3		
ADVAFLEX	1.07	66.6	4.7	0.5	0.1		
<b>TOTAL VOLUME</b>					<b>11.06 CF</b>		

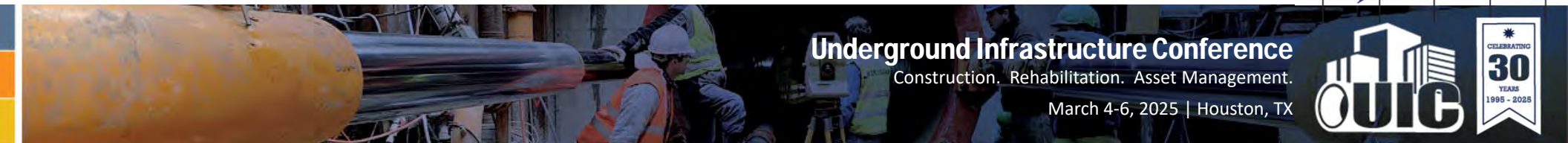
**NOTE :** The product will be mixed on site using a colloidal mixer with Cement & Flyash delivered in 1000 lbs supersacks.



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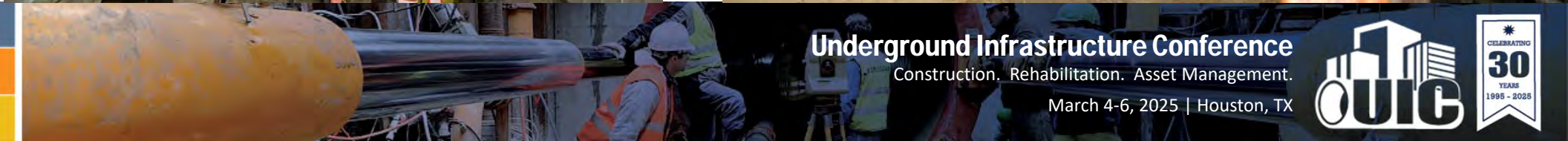
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# REHABILITATION Cont'd





# REHABILITATION Cont'd







# LESSON'S LEARNED

- Inspect sanitary sewer lines
- Empirical knowledge is valuable
- Plan – then always have a back-up plan
- Owner, engineer & contractor collaboration = successful project



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# QUESTIONS



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# Contact

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